



**NOAA Coral Reef Conservation Program
Southeast Fisheries Science Center
Activities and Accomplishments
2004-2006**



Compiled by: Jennifer Schull

**U.S. Department of Commerce
National Oceanographic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive, Miami, Florida 33149**

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NOAA Coral Reef Conservation Program

Southeast Fisheries Science Center

Activities and Accomplishments

2004-2006

U.S. Department of Commerce
Carlos M. Gutierrez, Secretary

National Oceanic and Atmospheric Administration
Vice Admiral Conrad C. Lautenbacher, Jr. USN (ret.)
Under Secretary for Oceans and Atmosphere

National Marine Fisheries Service
William T. Hogarth
Assistant Administrator for Fisheries

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Copies may be obtained by writing:

Jennifer Schull
NOAA Fisheries Service
75 Virginia Beach Drive
Miami, Florida 33149

National Technical Information Center
5825 Port Royal Road
Springfield, VA 22161
(800) 553-6847 or
(703) 605- 6000
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Dedicated to the Memory of Dr. Dail Brown

This report is dedicated to Dr. Dail Brown in loving memory and respect for his contributions to the conservation, study and management of coral reef ecosystems.



Dail was an ardent supporter of the Southeast Fishery Science Center's Coral Reef Research and Monitoring Program and he will be greatly missed by all of us here at the Center. His last directive to us was to work on an accomplishments report that would demonstrate the great work being done by SEFSC. We hope this report accomplishes that task. We mourn his passing and honor his life, legacy and contributions

SEFSC and the Coral Reef Conservation Program

A Letter from Dr. Nancy B. Thompson, Director - SEFSC

As director of the Southeast Fishery Science Center (SEFSC), it is my pleasure to introduce our *NOAA Coral Reef Conservation Program, Activities and Accomplishments, 2004-2006 Report*.



The SEFSC has a long history of conducting outstanding coral reef ecosystem monitoring and research, but the formal establishment of NOAA's Coral Reef Conservation Program (CRCP) in early 2000 under the auspices of the *Coral Reef Conservation Act* provided SEFSC with mandates, resources and the capacity to address research and monitoring gaps critical to the conservation and management of regional coral reef ecosystems. The CRCP is currently one of the most important programs in our region, and it continues to facilitate and strengthen partnerships and build capacity within NOAA, across Federal, State and Local agencies and resource managers, with the public and also international entities.

With the increasing interest in ecosystem science and management, the role of independently validated, credible science has never been more important. Our 2004 Coral Reef Program Review affirmed that the Center is delivering high-caliber science, and made recommendations on how we could do better. Specifically, the review recommended increasing project integration geographically, linking our science to management, expanding ecosystem-based science programs, and expanding our socio-economic projects. The SEFSC has strategically adopted these recommendations into our program, and this report highlights the strides we have made in several of these areas.

The Coral Reef Program at the SEFSC is highly integrated with other programs at the Center. Our researchers interface with protected resources (e.g. Acroporid corals, protected groupers), sustainable fisheries (e.g. reef fish stock assessments), and our habitat divisions. We are directly accountable to three regional fishery management councils in our jurisdiction and we work closely with them and NOAA's Southeast Regional Office (SERO) to ensure that our science is addressing the critical needs of management. We involve stakeholders through cooperative research projects and other activities, and greatly value their participation. We have also developed an extensive network of regional and international partners with whom we work. Finally, we place great emphasis on the dedication of contractors and graduate students, who continue to provide vital support and assist us in meeting our research goals.

The Center is currently engaged with other NOAA line offices, Federal agencies, universities, and our State and Territory partners to develop and implement the Comprehensive Caribbean Coral Reef Ecosystem Monitoring Project (C-CCREMP). This project will secure funding; facilitate collaboration with programs in the region; provide opportunities for program integration; and collect, analyze and store scientific data for better accessibility by researchers and managers. The integration of research objectives will result in strong multi-disciplinary projects whose results will inform ecosystem-based management. The Center is committed to this project and will continue to work with all involved for a successful implementation.

This report is for a general audience, aimed at introducing who we are, the types of work we do, and major accomplishments of our coral reef program since 2004. Many of our programs work together collaboratively, enhancing the strength and rigor of our inquiries. For example, as reef fish ecologists are learning about the behavior of spawning fish, our early life history team is following the fate of the larvae that are spawned. While benthic ecologists are learning about the effects of trap fishing on coral reef ecosystems, our socio-economists are studying the fishing communities that depend on trap fishing for their livelihood. Because of our emphasis on publication and data-sharing at important scientific meetings, we have included a list of publications, oral presentations, and posters given during this time period. I encourage you to learn more about our program by using the resources and contact information provided in this report.

- Dr. Nancy B. Thompson, Director, SEFSC

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Acronyms

| | |
|---------|---|
| CIMAS | Cooperative Institute of Marine and Atmospheric Studies |
| CRCP | Coral Reef Conservation Program |
| CRTF | Coral Reef Task Force |
| DOI | Department of the Interior |
| FFWCC | Florida Fish and Wildlife Conservation Commission |
| FKNMS | Florida Keys National Marine Sanctuary |
| GMFMC | Gulf of Mexico Fishery Management Council |
| HAPC | Habitat Area of Particular Concern |
| HBOI | Harbor Branch Oceanographic Institution |
| MPA | Marine Protected Area |
| NASA | National Aeronautics and Space Administration |
| NMFS | NOAA - National Marine Fisheries Service |
| NOAA | National Oceanographic and Atmospheric Administration |
| NOS | NOAA - National Ocean Service |
| NPS | National Park Service |
| NURP | National Undersea Research Program |
| PR DNER | Puerto Rico Department of Natural and Environmental Resources |
| RNA | Research Natural Area |
| ROV | Remotely Operated Vehicle |
| SAFMC | South Atlantic Fishery Management Council |
| SCUBA | Self Contained Underwater Breathing Apparatus |
| SAB | South Atlantic Bight |
| SEFSC | Southeast Fisheries Science Center, also abbreviated as “The Center” |
| SPAG | Spawning Aggregation |
| RSMAS | University of Miami Rosenstiel School of Marine and Atmospheric Science |
| UNC-W | University of North Carolina - Wilmington |
| UPR-M | University of Puerto Rico-Mayaguez |
| VI DPNR | Virgin Islands Department of Planning and Natural Resources |

The Southeast Fisheries Science Center

The Southeast Fisheries Science Center (SEFSC) is one of six research centers within the National Marine Fisheries Service (NMFS), also known as NOAA Fisheries, an agency of the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). The SEFSC is headquartered in Miami, Florida, and implements a science and research program that provides information and technology for fishery resource conservation, fishery development and utilization, habitat conservation, and recovery of protected resources and endangered species.

The SEFSC is responsible for the eight south-easternmost states, Puerto Rico, the U.S. Virgin Islands, and Navassa Island; and provides scientific support for NMFS' fishery management activities for the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils. The SEFSC interacts with the Gulf and Atlantic States Marine Fisheries Commissions and provides scientific support for U.S. participation in the International Commission for the Conservation of Atlantic Tunas (ICCAT), The United Nations International Oceanographic Commission for the Caribbean and Adjacent Regions (IOCARIBE); and the International Whaling Commission; amongst others. The SEFSC works jointly with the government of Mexico on projects of mutual interest in the Gulf of Mexico under MEXUS-Gulf.

The SEFSC oversees five laboratories, each with unique expertise and capabilities: Miami, Florida; Panama City, Florida; Beaufort, North Carolina (a joint National Ocean Service-NMFS Facility); Galveston, Texas (with facilities in Lafayette, Louisiana) and Pascagoula, Mississippi (with facilities in Stennis Space Center, Mississippi). The laboratories collaborate readily, and together, provide the tools needed to support ecosystem management of the region's resources efficiently and effectively. The SEFSC has two major NOAA research vessels berthed at Pascagoula, the 170 ft. Oregon II and the 224 ft. Gordon Gunter. SEFSC has a large fleet of smaller research vessels throughout the region which serve as platforms for various research activities.

<http://www.sefsc.noaa.gov>

Coral Reefs in the Southeastern U.S. and U.S. Caribbean

Coral reefs are exceptionally beautiful, dynamic, and valuable ecosystems. While they are only found in 0.2% of the world's oceans, they are home to approximately one-third of all marine fish species. They are homes for economically and ecologically important species, contain extraordinary biological diversity (highest density of vertebrates in the world), support endangered/threatened species, and provide economic benefit from non-extractive uses such as diving, snorkeling, photography and cultural activities. Coral reef related activities provide great economic benefit to the communities adjacent to them, for example: in 2000, southeastern Florida coral reefs were credited with contributing \$4.4 billion from recreational activities and over 70,000 jobs (Johns 2001); in 1990, Caribbean coral reef tourism earned \$8.9 billion and employed over 350,000 people (Jameson 1995).

Coral reefs of the southeastern U.S. and U.S. Caribbean are under great and increasing stresses from the density, intensity and scale of human activity taking place in their vicinity. Of particular importance are impacts due to fishing (e.g. extraction, trap effects), land runoff and coastal pollution (sediments, nutrients, and chemicals), and vessel groundings (including anchor damage). The prevalence of coral disease, proliferation of algae growth (both native and invasive species), coral bleaching and other climate-related impacts are also taking a heavy toll.

There are complex currents, oceanographic and biological processes that characterize and connect regional coral reef ecosystems across jurisdictional and international boundaries. Many of our coral reefs are downstream of other Caribbean reefs and may, therefore, be impacted by events and activities beyond our boundaries. For example, the *Diadema* sea urchin die-off of the 1980s; the prevalence and spread of coral diseases; loss of upstream spawning populations of grouper and lobster; coral bleaching; and climate change. These ecological inter-dependencies require cooperative research with regional partners to guide the development and implementation of effective management actions for addressing local and regional threats.

The SEFSC has a long history of conducting meaningful research and monitoring of the coral reef resources in this region. The SEFSC's jurisdiction includes the coral reefs of the South Atlantic, the Gulf of Mexico, and the U.S. Caribbean. Unlike any other region in the U.S., the SEFSC's work is linked to three different regional Fishery Management Councils; the South Atlantic Council (SAFMC), the Gulf of Mexico Council (GMFMC), and the Caribbean Council (CFMC). The SEFSC works closely with the councils to set and accomplish priorities that assist with the sustainable management and conservation of coral reef resources in the U.S.

References

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Johns, G. M., V. R. Leeworthy, F. W. Bell, and M. A. Bonn. 2001. Socio-Economic Study of Reef Resources in Southeast Florida and the Florida Keys. Broward County Department of Planning and Environmental Protection. Fort Lauderdale, Florida.

Coral Reef Research and Monitoring at the SEFSC

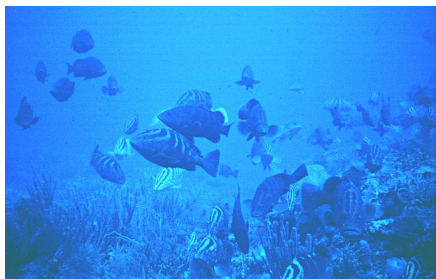
The goal of the SEFSC's Coral Reef Program is "to conduct science and research to support the conservation, protection and sustainable use of reef resources." Our activities include research to determine the extent and function of coral reef ecosystems (including benthic habitats, reef species, and connections with reef-related ecosystems); to determine the economic value and socio-cultural importance of reef resources (including extractive and non-extractive uses); to assess fishing impacts on coral reef ecosystems; to monitor and assess the status and support recovery of protected reef species; to research improved methods for restoring coral reef ecosystems; and to evaluate the effectiveness of existing and proposed management measure on reef resources and their users. The SEFSC also actively pursues improvement of its scientific enterprise through efforts such as the effective management of research data; increased collaboration and technology development; and support for science education, outreach, and capacity building to strengthen the scientific base applicable to reef resources and their utilization.

The quality of SEFSC's research is verified and improved upon by both internal and external review, publication in peer-reviewed forums, and presentations at scientific meetings. The SEFSC commissioned a comprehensive, external review of their Coral Reef Program in March 2004 to evaluate the technical quality and relevance of the program relative to NOAA's mission. The review identified research and science gaps, appropriateness of resource allocation, and made recommendations for the program. The panel concluded that a vast majority of SEFSC coral reef activities were being conducted in areas of clear relevance to the stated goals of NOAA and the Coral Reef Task Force; and were addressing current, pressing issues of national and international concern using the most innovative and groundbreaking methodologies. Areas targeted for improvement included the need for greater project integration with a geographic focus, more explicit linkages between science projects and management, ecosystem research, socio-economics, and genetics. These recommendations have been integrated into the SEFSC's priorities and are being implemented.

Coral reef research at the Center integrates the mandates of many regulatory frameworks in addition to the Coral Reef Conservation Act of 2000, such as the Magnuson-Stevens Fishery Conservation and Management Act (which manages our nation's fisheries), and the Endangered Species Act (which protects imperiled species), for a holistic approach to managing these diverse ecosystems. CRCP research at SEFSC relies heavily on coordination and extensive collaboration with NOAA, Federal, State, Territorial, Academic, NGO and private sector partnerships.

The projects presented in this report are highlights of SEFSC coral reef research conducted from 2004 through 2006. The goal of this publication is to effectively communicate the breadth and scope of the coral reef program at the SEFSC in an ecosystem context; highlight program accomplishments, partnerships, and products; and show how these efforts support the management and conservation of coral reef resources in the U.S.

Spawning Aggregations: Protecting the future



Spawning aggregations (SPAGs) occur when fish gather at a particular time and place to simultaneously reproduce en masse. A number of snapper and grouper species are well known for this behavior and fishers have learned over time when and where to expect and exploit these massive

aggregations. This effort has decimated the populations of many of these reef fish and many of these SPAGs have disappeared. SEFSC researchers are studying SPAGs to learn more about how and why fish aggregate to spawn, and how their populations respond once the aggregations are effectively fished out. Protecting SPAGs is important to ensure the reproductive success of these important resources and to ensure the larvae have the opportunity to travel throughout the Caribbean and southeastern U.S. to sustain reef fish populations.

Nassau grouper (*Epinephelus striatus*) used to be one of the most charismatic spawners in the Caribbean, but many of these SPAGs have been fished out, including in the U.S. Caribbean. SEFSC researchers traveled to the Bahamas and Cayman Islands to study healthy or currently exploited aggregations, to learn about the size, age, and sex of the fish that participate. Lessons learned were transferred to the Grammanik Bank in the U.S. Virgin Islands, where a once-decimated Nassau grouper SPAG seems to be reforming (other snapper and grouper species spawn here as well). SEFSC support and CRCP grant moneys are being used to conduct visual and acoustic surveys at Grammanik Bank, which was recently closed to fishing seasonally to protect spawning fish.

Mutton snapper (*Lutjanus analis*) also aggregate to spawn and are being monitored at Riley's Hump in the Dry Tortugas. **Michael Burton** has been studying this site for many years and is starting to document the reformation of the aggregation now that the site is protected from fishing.

SEFSC is investing in new technology to study aggregations. ROVs and drop camera arrays are being used in deep water habitats such as Madison-Swanson & Steamboat Lumps and the Oculina OHAPC. One of our recent success stories is the use of hydroacoustic sonar technology to locate red hind SPAGs in Puerto Rico. Our research was able to detect and quantify such valuable aggregations of fish, that the Puerto Rico Department of Natural Resources instituted a seasonal closure (see sidebar).

SEFSC research provides data leading to seasonal grouper closure

The Puerto Rico Department of Natural Resources (PRDNR) recently published regulations prohibiting all fishing of red hind (*Epinephelus guttatus*) during their spawning season (December 1st to February 28th) around the entire shelf in Puerto Rico jurisdictional waters. This management action, intended to reduce overfishing, was the direct result of SEFSC's & PRDNR's hydroacoustic research on fish spawning aggregations showing their re-appearing in specific locations in the Puerto Rico shelf. Closures apply to commercial and recreational fishing under Puerto Rico Fishing Regulations.



Early Life History of Coral Reef Fishes

Can fishes spawning off Mexico's Yucatan Peninsula supply Florida reefs with new recruits? How do environmental factors in Florida Bay affect fish populations on Florida reefs? SEFSC's Early Life History team is actively investigating answers to these questions about reef fish connectivity. Ecosystem-based coral reef and fishery management, including the use of place-based management tools (eg. MPAs), requires an understanding of the origins of fish larvae, their movements, and ultimate habitat needs.

SEFSC researchers, in partnership with El Colegio de La Frontera Sur (ECOSUR) in Chetumal, Mexico, are mapping spawning aggregations, larval distributions, and oceanic currents in the Caribbean to determine potential coral reef population connections with Florida reefs. Floating drifters released in the Yucatan quickly left the region, heading north towards Florida, indicating that fish larvae could easily travel along the same path. Light trap collections off Mexico yielded an unprecedented diversity of fish larvae, including tuna, bonefish and groupers that could all be heading in Florida's direction. Seven previously unreported species were also discovered.

On the Florida side, researchers have developed ground-breaking micro-chemistry techniques to determine the nursery grounds of juvenile snappers. Each distinct nursery ground leaves a specific chemical signature in the otoliths, or "ear bones" of fishes. This study is the first to use rare earth elements as tracer signatures in otoliths. Isotope analysis is further refining these results by enhancing this chemical signature and mapping out bodies of water each fish passes through. With this information, managers can determine linkages



between adult and juvenile habitats. A companion study using tiny acoustic tags is working to answer the questions of how, when, and why fishes move from their nursery habitats to adult habitats.

Results from this research provide managers with decision-making tools for long-term management of fish stocks, essential fish habitat, and the design of MPAs.

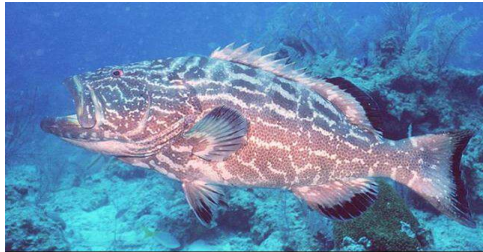
Xcalak, Mexico Workshop



Researchers, local fishers, business owners, and families attended a workshop by SEFSC researchers on the management and conservation implications of SEFSC's research efforts on the Meso-American reef tract. The standing room only crowd asked many excellent questions and were encouraged to examine, via microscopes, various specimens from collected samples. SEFSC researchers are dedicated to capacity building, outreach, and education in the environments in which they work.

Diving that Counts: Visual Reef Fish Assessments

How do you count coral reef fish? There are many ways; just ask **Dr. Jim Bohnsack**, head of the Protected Resources and Biodiversity Division at the SEFSC. Instead of assessing fish



populations at the dock by counting the catch, he developed a rigorous methodology that allows scientists to count fish underwater and accurately

determine coral reef fish composition and abundance, size structure, habitat preferences, and population condition. SEFSC's Reef Visual Census (RVC) team and partners at UM-RSMAS have amassed one of the most extensive and useful datasets in coral reef research today, painting a picture of how reefs have changed over the last 25 years!

The SEFSC team has spent thousands of hours underwater surveying the coral reefs of Southeast Florida, the Florida Keys and the Dry Tortugas collecting data that provides the basis for better understanding and managing coral reef ecosystems. Scientists can quantitatively compare different reefs and habitats to determine changes over time for most reef fish species. For example, scientists are comparing areas inside and outside of MPAs, and before and after events such as hurricanes and ship groundings to determine which changes are caused by natural events versus human activities. Resource managers are learning which management practices work the best by comparing areas under different protection regimes.

One of the main outcomes of this work has been verification of the effectiveness of MPAs, if properly designed. The SEFSC has documented increased numbers and sizes of economically and ecologically important reef fish (such as black grouper and yellowtail snapper) within MPAs and new results are helping to determine if MPAs benefit the surrounding fisheries as well.

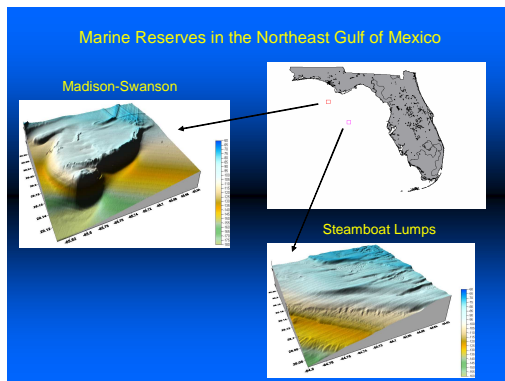
Additionally, this research is being integrated into traditional stock assessments, helping NOAA better manage coral reef fisheries.

SEFSC Scientists Provide Key Data for Protecting and Managing the Dry Tortugas

In 2006 the Florida Fish and Wildlife Commission unanimously approved the establishment of a 47 sq nm. Research Natural Area (RNA) in Dry Tortugas National Park. The RNA is a no-take marine protected area that will prohibit all extractive uses including fishing. The RNA will promote coral reef conservation and scientific understanding of coral reefs and complements adjacent Marine Ecological Reserves established in the FKNMS in 2001. This application of underwater visual assessment data was the result of successful collaborations between SEFSC, and partners at UM-RSMAS, the NPS, the FFWCC, and the FKNMS. A key factor in the Commission deliberations was the availability of many years of diver monitoring data and population assessments supported by the NOAA Coral Reef Program. Traditional NMFS fishery dependent monitoring programs alone could not have provided sufficient spatial resolution and precision necessary for this decision.

Mapping Reef Fish Habitat: Acoustic Technology at Work

NOAA is committed to mapping all U.S. Coral Reefs. Accurate, high resolution benthic maps provide data to managers on the location, extent, and quality of coral reef habitats. They can provide a baseline as habitat quality changes over time, for example, as a result of hurricanes or trawling activities. Maps

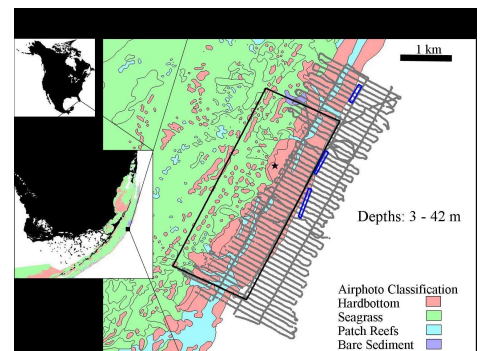


are essential for locating habitat in depths beyond those reachable by SCUBA diving and they help in the selection of MPA sites as well as suitable control areas, so scientists can monitor and evaluate the effectiveness of MPAs. SEFSC researchers work very closely with the regional fishery management councils to set priorities for mapping activities in our region and most of our activities use single and multi-beam acoustic mapping technologies. Both ship and subsurface multi-beam sonar systems provide acoustic imagery of deep reef systems by collecting bathymetric and

backscatter data. Automated seafloor habitat classification systems are now in use allowing for stratification and delineation of large areas. These methods require extensive logistical coordination with partners, vessels, and sophisticated equipment.

SEFSC's efforts have provided essential mapping information for site selection of five proposed MPAs in the South Atlantic (N. Carolina to S. Florida). The SAFMC will make a decision on these MPAs in 2007. Mapping of the Oculina Bank HAPC in the S. Atlantic provided managers with information on the location and extent of coral habitat in this heavily impacted area. Other work on Oculina is focusing on coral genetics and fish spawning habitat. In the northeastern Gulf of Mexico, SEFSC mapping efforts have characterized the Madison Swanson and Steamboat Lumps MPAs which were closed in 2000 to protect gag (*Mycteroperca microlepis*) spawning aggregations.

SEFSC researchers are also working with new single-beam acoustic technology to map finer-scale coral reef habitats in the Florida Keys. Results of these mapping activities have located previously un-identified preferred habitat for managed grouper species and have provided a way to map habitats that are out of reach of divers. Single beam technology is also being utilized at the Oculina Banks and for deep water habitat classifications and at Navassa Island.



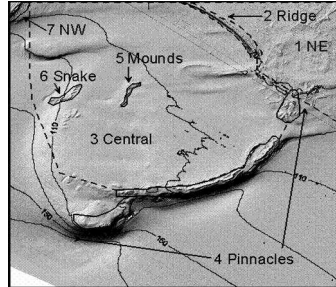
Single beam acoustic map

An initiative to map the habitats of Pulley Ridge (SW Florida), the deepest traditional coral reef in continental U.S began in 2006.

Healthy coral species exist here which are suffering from bleaching and other declines in adjacent shallow areas. Research here provides opportunities to discover why and how these corals are more resilient than their shallow counterparts.

Characterizing Reef Fish Habitat

Many coral reef fishes, especially those in the snapper-grouper complex are either overfished or are facing serious declines. By monitoring reef fish and the habitats on which they depend, researchers can investigate the linkages between reef fish and their associated habitats to facilitate the recover of these economically and ecologically important fishes. Researchers are also able to determine if management measures, such as MPAs, are working.



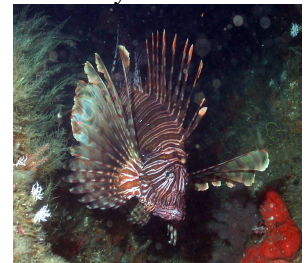
Multibeam map of the Madison Swanson MPA in the NE Gulf of Mexico

SEFSC, under the leadership of **Andrew David**, has developed expertise in describing the location and quality of reef fish habitats in deep water, beyond the reach of SCUBA. Remotely Operated Vehicles (ROVs), drop cameras, video arrays, and acoustic techniques have been developed to help assess fish stocks and habitat conditions in these remote areas. These surveys provide managers with information on reef fish habitat utilization; species composition, abundance and distribution; and (at times) spawning behavior. Concurrent mapping activities locate habitat features and aid in uncovering the relationship between habitat and fish assemblages. These studies can assist in examining proposed MPA sites before implementation of fishing restrictions, providing fishery managers with baseline data upon which they can evaluate the effectiveness of the closures. Current projects focus on abundance and distribution of grouper and other economically valuable species and habitat on deep reefs on the continental shelf edge in the eastern Gulf of Mexico and U.S. South Atlantic Bight (SAB). Annual surveys have been conducted in the Madison-Swanson and Steamboat Lumps reserves since their establishment in 2000. Research cruises to several proposed MPAs in the SAB provided baseline data on fish and habitat prior to closures and helped managers select the exact areas for the fishing restrictions.

Shallow water habitat characterization projects are being conducted in the Florida Keys. One study examined hogfish habitat utilization, reproductive output, and harem structure in fished versus unfished areas. The other is investigating grouper habitat utilization, behavior and seasonal movements. Both studies are using a combination of visual surveys, acoustic and visual habitat mapping, and acoustic tagging technology. In one of the studies, an acoustic array of 23 receivers in the FKNMS is tracking grouper behavior and movement patterns.

SEFSC scientists encounter an unwelcome resident in the South Atlantic

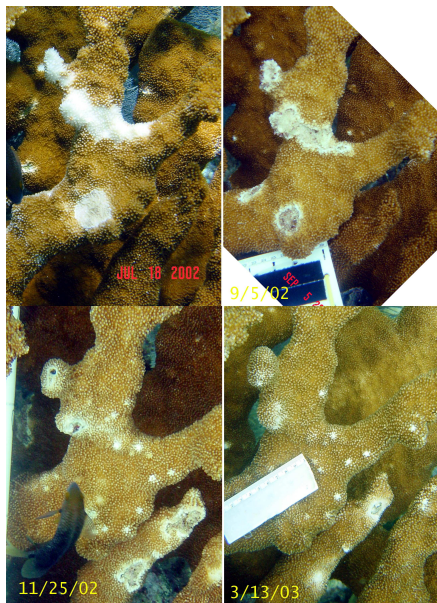
While surveying the 5 proposed SAB MPAs, SEFSC researchers found surprising numbers of the non-native Pacific lionfish (*Pterois volitans*) in their surveys. Their presence is particularly alarming because they are apex predators and are competing with commercially and ecologically important groupers for resources. They are now known to inhabit waters as far north as North Carolina (young as far north as Long Island). They are also found off Bermuda and the Bahamas. Their numbers and distribution seem to be increasing over time. While eradication is impossible at this point, SEFSC researchers are working closely with NOS (Beaufort) to monitor populations of this invasive species to see how it is spreading and how their presence is impacting the ecosystems where they are now found.



A First for the ESA: Threatened Corals

For the first time in the history of the Endangered Species Act, two coral species, Elkhorn and Staghorn (*Acropora palmata* and *A. cervicornis*), have been listed as Threatened. SEFSC researchers were not only instrumental in providing the information on the precipitous decline of these Atlantic basin corals that necessitated their protection, but are now leading the way in determining why these declines occurred and the steps to take to monitor and recover these fragile corals.

SEFSC's benthic ecology team, under the leadership of **Dr. Margaret Miller**, is surveying *Acropora* distribution, abundance, and health; monitoring trends in these parameters over time. By working with local and regional partners, researchers are working towards developing monitoring programs for South Florida, the Florida Keys, the U.S. Caribbean and the wider Caribbean basin to get population estimates throughout much of *Acropora*'s range. Biologists are also monitoring specific colonies over time,



Recovery of an *A. palmata* colony infected with white pox disease

with over 180 Florida Keys colonies tagged. By following these colonies over time, researchers are learning about coral growth, survival, and the relative impact of various threats (e.g., bleaching, disease, storms, predation) on each colony, and, in some cases, recovery (see photo). They are also learning that combinations of impacts can be particularly devastating. For example, a hurricane or bleaching event can weaken corals to the point that it is easy for diseases or predators to take hold and kill.

Other work has focused on *Acropora* reproduction, predator dynamics,

disease transmission, genetics and settlement, and these results are helping with reef restoration success (see Restoring Reefs below) and ultimately, recovery of these threatened corals. SEFSC biologists have just released a manual entitled "Demographic monitoring protocols for threatened Caribbean *Acropora* spp. corals" available on line at:
<http://www.sefsc.noaa.gov/PDFdocs/Acropora%20Manual-Electronic.pdf>

SEFSC scientists unlocking the secrets to coral genetics

Groundbreaking genetics studies on *A. palmata* and *cervicornis* have shed light into the diversity and resilience of these protected corals. With new genetic tools developed by SEFSC scientists working in partnership with UM-RSMAS, biologists are finally learning how corals reproduce to populate new areas and how genotypic diversity relates to coral resilience. New publications explain that there are distinct populations of *A. palmata* in the Eastern and Western Caribbean. It appears the E. Caribbean population is genotypically more robust than its western counterpart with the eastern population showing higher diversity and overall healthier populations. The only outlier to this geographic pattern, interestingly, is the population in Navassa (see Navassa Island story), which has the highest genotypic diversity of any of the regions sampled, suggesting that Navassa may be a sink for coral larvae that were spawned in other areas. These results underscore the importance of understanding the genetic differences between coral populations throughout the entire range of the species, and how these differences can impact coral survival and recovery.

Restoring Reefs



Spawning A. Palmata

Coral reefs are subjected to a variety of threats, both manmade and natural. While damage to coral reefs can happen instantaneously (for example, ship groundings or hurricanes), it can take decades or longer for reefs to recover. Given the possible loss of resilience in coral reef ecosystems, recovery may never be complete.

With the recent listing of *Acropora* corals (one of the main reef-building coral in Atlantic waters) as Threatened under the ESA, we must determine if humans can assist in the restoration and hasten recovery of fragile corals and the ecosystems they support. SEFSC researchers and their partners are developing and evaluating diverse restoration approaches.

Most reef-building corals reproduce by broadcasting their tiny gametes into the water column. Researchers can collect these eggs and sperm as they are released from parent colonies and enhance fertilization and settlement success by caring for the larvae in a laboratory setting.

SEFSC, in partnership with UM-RSMAS and UNCW are raising tens of thousands of coral larvae each year for various experiments and for restoration activities including settlement directly on reef surfaces or other substrates that can be transplanted on reefs as they mature. Experiments are designed to determine what treatments encourage coral survivorship and growth. A new discovery is that cyanobacteria (which can be a sign of a damaged or unhealthy reef) can inhibit coral settlement. A pilot study is evaluating new ceramic artificial structures to see if their unique design may improve survivorship of coral settlers.



Other restoration work is focusing on re-attaching broken coral fragments to rebuild coral reefs. When the M/V Fortuna Reefer grounded on Mona Island, Puerto Rico in 1997, NOAA led a multiagency restoration action, re-attaching approximately 1800 *Acropora* fragments. By following the success of these colonies over time, researchers have learned which methodologies yield the best results. Specifically, the type of substrate, the size

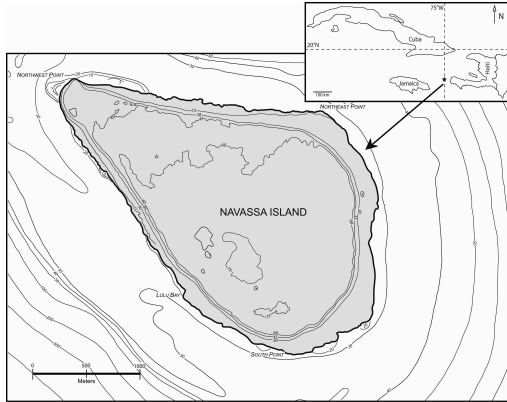
of the attached fragments, and the method of attachment all impact coral success. While it has been almost a decade since these activities began, the site is still not fully recovered. However, when compared to comparable grounding sites that were not restored, the restoration sites are a vast improvement with growing coral fragments and fish abundance and diversity increasing, demonstrating the positive impact NOAA's restoration activities are having. Long term, frequent, monitoring of restoration activities is very important to learn how restored areas respond in the face of ongoing threats and impacts to coral reefs.

SEFSC Restoration Activities featured in Jean Michel Cousteau's America's Underwater Treasures

Dr. Margaret Miller and her collaborators at UNCW and UM-RSMAS were featured in a coral spawning segment on this nationally televised special highlighting our nation's National Marine Sanctuaries. The film crew followed the researchers' efforts from spawn collection (through Hurricane Katrina) to the release of larvae to settle at a reef restoration site.



Navassa Island: A Case Study in Ecosystem Management



Navassa is a small isolated island to the west of Haiti that is designated as a National Wildlife Refuge by the U.S. Fish and Wildlife Service. What started out as a coral assessment of a fairly pristine, remote location has evolved into a multi-agency, multi-faceted effort to learn about the health of this unique environment. The

characterization of this island is one of our best examples of an integrated ecosystem assessment; incorporating benthic ecology, reef fish assessments, and human dimensions.

Why Navassa? The US has a legal mandate to assess and monitor coral reef resources of the U.S. Additionally, Navassa, because it is remote and undeveloped, provides researchers with an opportunity to study reef health without the complexities of local land-based effects. However, Navassa is facing increased fishing pressure from Caribbean fishers in the region. To assess and monitor the rapid escalation in fishing pressure, SEFSC's coral researchers enlisted the help of RVC fish counters (see Diving that Counts above) and our socio-economic team (See Socioeconomics below) to quantify the impacts of their activity. Recent



results show that fishing is having a rapid impact on the areas' fisheries, with significant declines in size and abundance of reef fishes (two very active hurricane seasons may be impacting ecosystem health as well). The recently completed first socio-cultural assessment of the Haitian fishing communities exploiting Navassa fisheries was completed in 2006, documenting catch and effort and fisher perceptions (see sidebar).

Other significant results from research on Navassa include a guide to the island's sponge community, completion of multi-beam and single beam hydroacoustic (partial) habitat maps, long term monitoring of the island's benthic community structure, genetic characterization of Navassa's *Acropora* corals, documentation of a coral disease outbreak in 2004, and discovery of 30+ previously undocumented reef fishes.

SEFSC scientists work with Fondation pour la Biodiversité Marine (FoProBim) to understand fishing pressure on Navassa Island

SEFSC researchers uncovered an active fishery on Navassa Island, a small island ~40Km from the southwest coast of Haiti. By contracting with FoproBim, an NGO specializing in coastal resources issues in Haiti, SEFSC researchers completed a comprehensive description of the fishery at Navassa. This assessment characterizes the fishing pressure to help researchers look at possible links to habitat health and apparent decline in fish stocks. It is a good example of federal researchers partnering with a local non-governmental organization to collect vital information for ecosystem management.

Socioeconomics: Linking People and Coral Reefs

Coral reefs provide economic and cultural benefits to communities worldwide. In the S. Atlantic and Caribbean region, SEFSC's social scientists are conducting socioeconomic and cultural assessments fishing communities to obtain broad, region-wide overviews of fishing activities, and to characterize the economic and sociocultural importance of reef resources in this jurisdiction. The information collected assists the Fishery Management Councils in meeting their mandates.

Additionally, this work helps managers interject human dimensions into comprehensive coral reef ecosystem management.



Major activities over the last few years have centered on the characterization of the fishing communities in Puerto Rico and the U.S. Virgin Islands. This information provides a baseline for future ecosystem and management changes, helps evaluate the performance of fisheries management and how regulations are perceived by fishers, and provides guidance on how management can mitigate regulatory impacts on fishing communities. These assessments are being done with standardized methods so that these assessments can be repeated in new areas, or over time. Workshops in the region ensure an iterative process where users can review and comment on preliminary findings, and researchers can collect additional data and fine-tune their analysis. These workshops build rapport with local stakeholders and ensure the relevance of research findings. Final reports for Puerto Rico and St. Thomas/St. John are completed, and the St. Croix report will be finished in early 2007.

In another project, researchers are creating a database tool with information on the spatial distribution of recreational fishing effort in S. Florida. The tool is geographically referenced and will be web-based for easy access. Resource managers will be able to use the tool to evaluate the



concentration of recreational fishing near coral reef resources and identify the relative amounts of inshore and offshore fishing effort.

Overall, SEFSC's human dimensions work is a close collaboration between researchers, stakeholders, state and territory managers and the Fishery Management Councils. Five regional contractors help manage these projects and nine graduate students have been supported with this work.

Outreach and Education: Getting our messages out



Talking to students about deep water corals

Outreach and Education on coral reefs is a crowded field, so researchers at the SEFSC choose their messages carefully to compliment existing campaigns and highlight the important work being done at the Center. One area critically underrepresented in the Southeast is deep water corals. Two campaigns worked to increase awareness of the threats to these resources and what the SEFSC is doing to monitor and protect them. Partnerships and cooperation were essential themes for these projects.

SEFSC partnered with several local and regional entities, including the SAFMC, NURP, HBOI, and the Smithsonian to create a multi-faceted campaign about the importance of the Oculina HAPC and associated research and monitoring efforts. Highlights included a teacher workshop, developing signage for the only Oculina exhibit in the world located at the Smithsonian's Ft. Pierce Field station, printing and distribution of posters, rack-cards, and fact sheets; and development of web-based information.



The Smithsonian Oculina Exhibit

At the explicit request of the GMFMC, researchers prepared an informational poster on the Madison Swanson and Steamboat Lumps Marine Reserves detailing the location of and regulations for these reserves. These posters were mailed to over 900 contacts throughout the northeastern Gulf.

Additional Outreach Efforts included 2 workshops in Mexico on larval fish and the importance of mangrove habitats to coral reef health (see sidebar). These workshops were well attended by community members from broad backgrounds. These workshops help introduce SEFSC research to the communities in which we work, building rapport and support. CRCP funds also supported the 1st International Symposium on Mangroves as Fish Habitat (see next page).



The CRCP Supports Mangrove Workshop in Mexico

SEFSC researchers held a workshop entitled "Conservation and Sustainable Use of Coral Reefs and Associated Habitats in the Mayan Riviera" in Cancun, Mexico, June, 2006. The workshop was taught in Spanish by facilitators familiar with environmental and socio-economic problems in the Mexican Riviera. The workshop included fieldtrips to local coral reef and mangroves. The 32 attendees represented diverse backgrounds: resource managers, architects, engineers, tourism developers, and marine park officials. Feedback provided by participants showed they learned real-world lessons in sustainable use of resources in their region and many participants encouraged NOAA-CRCP to continue with this type of capacity building. Products from this workshop included 1) workbooks for workshop attendees including CD-ROM with articles, references, web sites, an educational bookmark, and Coral Reef Program t-shirts 2) a short film with testimonials from 8 of the 32 workshop participants and 3) a compilation of selected articles from the workshop teachers on issues that were addressed at the workshop.

1st International Symposium on Mangroves as Fish Habitat



Mangroves are conspicuous components of tropical and subtropical ecosystems around the globe; they cleanse coastal waters by acting as buffers that absorb excess nutrients and retain land-based sediments. They provide critical nursery habitat for coral reef fish and invertebrates, many of which are of high commercial and ecological value. Unfortunately, mangroves have only recently received focused attention from the international scientific and conservation communities as potentially important fish habitats — habitats which are rapidly shrinking worldwide.

The Southeast Fisheries Science Center and NOAA's Coral Reef Conservation Program, along with The Pew Institute for Ocean Science, Environmental Defense Fund, United States Geological Survey, International Society for Mangrove Ecosystems and The Nature Conservancy, hosted the First International Symposium on Mangroves as Fish Habitat at the University of Miami's Rosenstiel School of Atmospheric and Marine Science from April 19-21, 2006. SEFSC biologist, **Dr. Joe Serafy** coordinated this highly successful symposium which attracted over 160 scientists, managers and educators from 25 nations around the globe.

The symposium comprised six sessions: (1) Nursery and Trophic Function; (2) Community Ecology and Connectivity; (3) Mangrove-Fishery Linkages; (4) Disturbance and Restoration; (5) Conservation and Management; during which 56 presentations were made. Twenty-six posters were displayed throughout the workshop. Thirty-eight manuscripts were submitted for the Symposium Proceedings. These are slated to appear in a special issue of the *Bulletin of Marine Science* in May, 2007 after peer review.

Among the many scientific highlights was the application of new and novel techniques and approaches towards resolving mangrove function and connectivity. These included advanced molecular methods, stable isotope analyses, otolith microchemistry investigations, and the use of electronic tagging systems and dual-frequency sonar among the prop-roots. Of particular importance were contributions from developing nations including Brazil, Colombia, Costa Rica, Ecuador, Guatemala, India, Indonesia, Kenya, Malaysia, Mexico, Peru, Philippines, Tanzania and Thailand.

The symposium's program is available at: http://www.rsmas.miami.edu/conference/mangrove-fish-habitat/pdf/Agenda_Final.pdf

Collaboration: Towards a Comprehensive Monitoring Program in the U.S. Caribbean

The US Caribbean is a unique and complex region, comprised of diverse habitats and communities, impacted by regional influences (natural events, man-made changes, developmental and tourist pressures, and geopolitical issues) that are not easily quantified or understood. A coordinated understanding of the structure and function of coral reefs across the region improves our ability to manage reefs and reef resources.

Multi-faceted research and monitoring efforts are ongoing, investigating critical elements of the region's coral reefs: extent and causes of coral diseases and bleaching, efficacy of coral restoration, distribution and viability of reef fish spawning aggregations, recovery of depleted conch populations, and effects of trap fishing on coral reefs. Studies of larval fish ecology elucidate regional connectivity between Caribbean, Meso-American and Florida Keys reefs. Socioeconomic studies characterize user communities and explore the effects and effectiveness of management measures. Ecosystem models will predict effects of management changes and provide a path towards greater ecosystem-based resource management in the US Caribbean.

In order to gain efficiency and prevent redundancy, NOAA's Fisheries Service (SEFSC) and Ocean Service (Biogeography Team) are leading the way towards a comprehensive coral reef monitoring effort for the entire region. In the first year of operation (FY-2006), the US Caribbean Comprehensive Coral Reef Ecosystem Monitoring Project has accomplished:

Comprehensive Monitoring Implementation Plan: This plan uses the expertise of the broader NOAA research community, seeking to integrate monitoring across the region and to enhance regional assessment capabilities. Initial products include a geospatial database to document methods and locations and a web-based interface for user input of project metadata.

Comprehensive Monitoring Workshops: Workshops in U.S. Caribbean highlighted research and management activities from territorial and commonwealth agencies, the Caribbean Coral Reef Institute, local universities, other federal agencies, and NOAA. The workshops identified and prioritized research and monitoring gaps, and opportunities for integrating future activities. Researchers discussed how to foster collaboration between regional, federal, and international researchers and managers.

Caribbean Coral Bleaching Activities: Researchers responded to the unprecedented 2005 bleaching event by supporting workshops that documented conditions and created rapid response plans for bleaching; funding joint NOAA/NASA bleaching assessments (conducted with DOI, UPR-M and other partners) using a digital camera and the NASA Airborne Visible Infrared Imaging Spectrometer (AVIRIS); and conducting concurrent field missions documenting reef conditions.



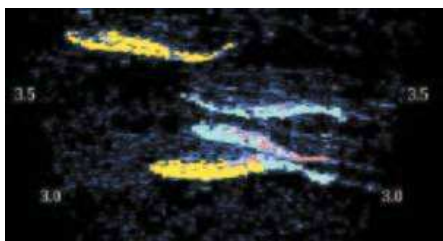
Spotlight on U.S. Caribbean Research: Trap Effects on Coral Reefs

Trap fishing is the most common method of reef fishing worldwide and SEFSC researcher **Dr. Ron Hill** is working with local partners to assess the interaction between traps and corals and associated reef habitats. Research in the U.S. Caribbean and Florida Keys, using standardized methods, is quantifying the spatial distribution and effects of traps over time. Preliminary results suggest that most traps are not placed directly on coral reefs, but on adjacent habitats such as mud, seagrass, algal plains, and hardbottom habitats. Researchers are able to make seasonal, inter-annual, and interregional comparisons, and are examining the fate of damaged organisms. They have also been documenting how traps move and affect corals during storm events (especially hurricanes). By monitoring the trap fisheries over time, researchers are providing essential information to management about the sustainability of fishing practices throughout the region.

The Cutting Edge: Investing in New Technology

With support from the CRCP, the SEFSC is investing in groundbreaking new technology to learn about coral reefs. These technologies help researchers learn more about the ecosystems they study, provide access to regions that are inaccessible, and provide new efficiencies in coral reef research.

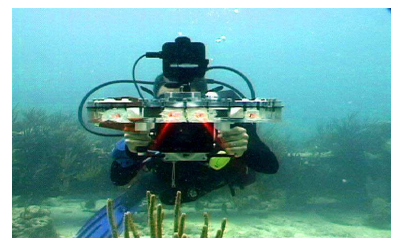
- Dual frequency sonar (DIDSON) is allowing researcher to monitor coral reef activity at night or in very turbid waters, when video or diver observations are impossible.
- Advances in acoustic tagging and telemetry are helping researchers monitor fish movement patterns and behaviors under a variety of circumstances. Current projects are looking at grouper behavior in protected areas, and juvenile gray snapper in estuaries.
- Otolith microchemistry and isotope analysis, which utilize trace element signatures in the otoliths (or earbones) of fishes, are helping researchers track fish from their juvenile habitats to adult habitat (this, combined with the above mentioned tagging techniques, is providing critical information on fish habitat usage)
- Ultrasound techniques (University of the Virgin Islands) are being used to determine the sex of fish without invasive measures
- Stereo-video creates a three dimensional image of coral reef fishes and habitats, providing better estimates of fish size when direct visual observations are not possible. Lasers mounted onto video systems also assist in measuring fish lengths.
- Deep water and closed-circuit (re-breather) diving techniques, which are becoming more accessible, give divers better tools for observing the environment safely and with less impact on their subjects
- New genetic techniques have been developed to determine clonal diversity in the *Acroporid* corals, helping researchers determine the relationships amongst the region's corals and answering questions about differences in coral resiliency



DIDSON image



Micro-acoustic tag



Lasermetric measuring device

SEFSC Coral Reef Program

Principal Investigators and Research Areas

2004-2006

Dr. Juan Agar, SEFSC Miami, FL juan.agar@noaa.gov

- Socio-economic analysis of marine reserves in the U.S. Caribbean
- Economics of trap-fisheries in the U.S. Caribbean
- Profiling fishing communities in Puerto Rico and the U.S. Virgin Islands

Maria Bello, SEFSC Miami, FL maria.bello@noaa.gov

- Marine Conservation Workshops in the Latin Caribbean
- Library Science

Dr. Jim Bohnsack, SEFSC Miami, FL jim.bohnsack@noaa.gov

- Marine Protected Areas
- Coral reef fish ecology and population dynamics
- Dry Tortugas Reserve monitoring
- Stereo-video monitoring technology

Dr. Theo Brainerd, SEFSC Miami, FL theo.brainerd@noaa.gov

- Coral Reef Program management and outreach
- Fishery policy and planning
- Economics of natural resource management

Michael Burton, SEFSC Beaufort, NC michael.burton@noaa.gov

- Fish assemblages and habitat structure of the Ten Fathom Ledge, North Carolina
- Riley's Hump and Tortugas Banks reef fish assemblages and spawning aggregations
- Effects of MPA's on recovering exploited reef fish populations

Dr. David Carter, SEFSC Miami, FL david.w.carter@noaa.gov

- Economic analysis of recreational fishing in Florida, Gulf of Mexico, and U.S. Caribbean
- Graphical user interface for spatial and socioeconomic analysis of recreational fishing

Andrew David, SEFSC, Panama City, FL andy.david@noaa.gov

- Habitat and fish assemblage at the Madison Swanson and Steamboat Lumps Reserves in the NE Gulf of Mexico, and in the five proposed Type II MPAs in the U.S. South Atlantic Bight
- Multibeam mapping of shelf edge reef habitats, NE Gulf MPAs, South Atlantic MPAs, Oculina HAPC and Pulley Ridge (SW Florida)
- Ecology of the Oculina HAPC

Jennifer Doerr, SEFSC Galveston, TX jennifer.doerr@noaa.gov

- Conch population recovery in the U.S. Virgin Islands

Dr. Sarah Frias-Torres, CIMAS/RSMAS, sarah.friastorres@noaa.gov

- Dual frequency sonar (DIDSON)
- Spawning aggregations, ecology, and behavior of groupers
- Outreach and Education
- Hydroacoustic Technology

Walt Gandy, SEFSC Stennis, MS walt.gandy@noaa.gov

- Impact of illegal spiny lobster habitats
- Remote sensing technology development

Christopher Gledhill, SEFSC Pascagoula, MS christopher.t.gledhill@noaa.gov

- Habitat and fish assemblages in the Madison-Swanson and Steamboat Lumps Reserves in the NE Gulf of Mexico
- Multibeam mapping and cross-shelf mapping of the west Florida shelf

Dr. Rex Herron, SEFSC, Stennis, MS. Rex.c.herron@noaa.gov

- Impact of illegal spiny lobster habitats

Dr. Ron Hill, SEFSC Galveston, TX ron.hill@noaa.gov

- Effects of trap fishing on coral reef habitats
- Modeling community changes in reef fish habitats
- Dynamics of reef fish communities
- Vessel grounding site recovery, Fortuna Reefer, Mona Island
- Flower Garden Banks resources and adjacent habitats

Dr. David Jones, CIMAS/RSMAS, dave.jones@noaa.gov

- Early life history of fishes

Dr. Todd Kellison, SEFSC Miami todd.kellison@noaa.gov

- Reef fish ecology
- Fish-habitat relationships
- Habitat connectivity
- Fisheries management

Dr. John Lamkin, SEFSC Miami, FL john.lamkin@noaa.gov

- Larval fish ecology
- Reef fish utilization of marine protected areas and adjacent habitats
- Mesoamerican reef larval fish distribution and retention
- Otolith microchemistry and larval fish connectivity

Dr. Monica Lara, CIMAS/RSMAS, monica.lara@noaa.gov

- Early life history of fishes
- Otolith microchemistry

Dr. Margaret W. Miller, SEFSC Miami, FL margaret.w.miller@noaa.gov

- Ecology and status of the *Acroporid* corals.
- Ecological restoration of vessel grounding sites
- Coral disease research and monitoring
- Coral reef ecology of Navassa Island
- Ecology of the Oculina Banks, SE Florida

Dr. Roldan C. Muñoz, SEFSC Beaufort, NC roldan.munoz@noaa.gov

- Ecology, reproduction and habitat utilization of fishes (esp. wrasses and parrotfishes)
- Fishing effects on sex change, reproductive output, and movements of fishes
- Molecular genetics

Dr. Bill Richards, SEFSC Miami, FL bill.richards@noaa.gov

- Larval fish biology and ecology
- Recruitment of larval fishes to marine protected areas

Dr. Jose Rivera, Independent Contractor, Boqueron, PR, JARivera@msn.com

- Fish spawning aggregations
- Hydroacoustics technology

Jennifer Schull, SEFSC Miami, FL jennifer.schull@noaa.gov

- Goliath grouper ecology and biology
- Nassau grouper spawning aggregation ecology
- Outreach and Education

Dr. Joe Serafy, SEFSC Miami, FL joe.serafy@noaa.gov

- Ontogeny and multiple habitat use of reef fishes
- Mangrove and seagrass habitats, watershed influences and reef connectivity
- Use of dual-frequency sonar (DIDSON) in low-visibility environments

Dr. Brent Stoffle, SEFSC Miami, FL brent.stoffle@noaa.gov

- Profiling fishing communities in Puerto Rico and the U.S. Virgin Islands
- Oral history and contemporary assessment of Navassa Island fishermen
- Social impact assessments

Samantha Whitcraft, CIMAS/RSMAS, samantha.whitcraft@noaa.gov

- Coastal conservation and estuarine-marine habitats connectivity
- Comprehensive Everglades Restoration Plan (CERP) and South Florida estuaries
- Policy/research linkages in South Florida coastal and estuary ecosystems

Dr. Dana Williams, CIMAS/RSMAS, dana.williams@noaa.gov

- *Acropora* population ecology
- Coral disease

SEFSC's Coral Reef Research and Conservation Partners

Federal

Army Corps of Engineers

National Aeronautics and Space Administration (NASA)

National Environmental Satellite Data and Information Service (NESDIS)

National Ocean Service

 National Centers for Coastal Ocean Science - NCCOS

 Office of National Marine Sanctuaries - ONMS

 Florida Keys National Marine Sanctuary

National Park Service

 Biscayne National Park

 The Dry Tortugas National Park

 Virgin Islands National Park Service

The National Undersea Research Program

 National Undersea Research Center (NURC)

 At University of North Carolina at Wilmington

 At University of Connecticut

 Caribbean Marine Research Center

Oceanic and Atmospheric Research (OAR)

 Atlantic Oceanographic Meteorological Laboratory (AOML)

The Smithsonian Ft. Pierce Research Station

The Southeast Regional Office (SERO)

The U.S. Geological Survey

The U.S. Fish and Wildlife Service

Fishery Management Councils

The Caribbean Fishery Management Council

The Gulf of Mexico Fishery Management Council

The South Atlantic Fishery Management Council

State & Territorial

Florida Fish and Wildlife Conservation Commission

Florida Fish and Wildlife Research Institute

Florida Institute of Oceanography

Puerto Rico Department of Natural and Environmental Resources

U.S. Virgin Islands Division of Fish and Wildlife

Local/Regional

Miami-Dade County Environmental Resource Management (DERM)

Private

BAE Systems

Battelle; Pacific Northwest National Labs

Boqueron Aquatic (Dive) Center

Estuarine, Coastal and Ocean Science, Inc. (ECOS)

Harbor Branch Oceanographic Institute

Seafloor Systems, Inc.

Academic

El Colegio de La Frontera Sur (ECOSUR) - Mexico

Florida Atlantic University

Florida International University

Louisiana State University

Old Dominion University

Penn State University

Pfleger Institute of Environmental Research (PIER)

Sea-Mester

Universidad del Caribe, Cancun, Mexico

University of Connecticut (via NURC)

University of Miami - Work Study Program

University of Miami – Rosenstiel School of Marine and Atmospheric Science

Cooperative Institute of Marine and Atmospheric Studies (CIMAS) – A NOAA/UM
Partnership

University of North Carolina at Wilmington (via NURC)

University of Puerto Rico

University of South Florida

University of the Virgin Islands

NGOs

Environmental Defense

Fundacion pour la Protection de la Biodiversite Marine (FoProBim)

John G. Shedd Aquarium

The Perry Institute of Marine Science

The Reef Environmental Education Foundation (REEF)

International

Cayman Islands Department of Environment

Direccion de Medio Ambiente (Local Government Environmental Agency)

Ayuntamiento de Solidaridad, Quintana Roo, Mexico

SEFSC Publications

Publications resulting from work supported by the CRCP 2004-2006

2004

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Dr. Bill Richards Publishes Early Stages of Atlantic Fishes; An Identification Guide for the Western Central North Atlantic

Dr. Bill Richards saw his guide to the identification of the early stages of fishes published in 2005 in a two-volume book entitled "Early Stages of Atlantic Fishes; An Identification Guide for the Western Central North Atlantic". This 2,640 page treatise provides current information on the Early Live History of all 214 families known to inhabit this area, with contributions from over 70 larval fish experts. 20 SEFSC CR researchers authored 160 chapters (out of 215). The book provides complete information on all aspects needed to identify eggs, larvae, and juveniles – foundational information that is needed for understanding the complex biology and ecology of fishes.

2005

Acropora Biological Review Team (**M.W. Miller**, Contributor), (2005) Atlantic Acropora Status Review Document. Report to National Marine Fisheries Service, Southeast Regional Office. 152 pp + App.

Ault, J.S., **J.A. Bohnsack**, and S.G. Smith. 2005. Towards sustainable multispecies fisheries in the Florida USA coral reef ecosystem. *Bulletin of Marine Science*, 76(1).

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Bartholomew, A. and **J.A. Bohnsack**. 2005. A review of catch-and-release angling mortality with implications for no-take reserves. *Reviews in Fish Biology and Fisheries* 15: 12-154.

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Epstein, N., M.J.A. **Vermeij**, R.P.M. Bak, and B. Rinkevich. 2005. Alleviating impacts of anthropogenic activities by traditional conservation measures: can a small reef reserve be sustainably managed? *Biological Conservation*. 121: 243-255.

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